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The San Juan and Espada Acequias: Two Historic Cultural Landscapes Preserved, Restored and Adapted as Contemporary Urban Agriculture

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The San Juan and Espada Acequias: Two Historic Cultural Landscapes Preserved, Restored and Adapted as Contemporary Urban Agriculture

by

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Dedication

This report is dedicated to my family who have supported me with their wisdom and care from day one. To my Father, whom I credit for my love of the outdoors and the parks we create to celebrate our natural world. To my Mother, whom I credit for instilling a lifelong love of learning and creation. To my brother, who challenges me to live my best life and to always be critical of the status quo. Finally, to my grandmother Patsy, whose humility and respect for all people inspires me to always act with kindness and generosity.

This Report is also dedicated to Professor Robert Young, who was to be co-supervisor of this writing before passing away in January of 2018. His fiery passion for nature and respect for the wisdom of time were major inspirations for the writing of this report. I hope this writing may be a valuable contribution to the literature of Ecological Wisdom, a concept which he introduced to me and has since become a central theoretical pillar of my planning practice.

The San Juan and Espada Acequias: Two Historic Cultural Landscapes Preserved, Restored and Adapted as Contemporary Urban Agriculture

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The University of Texas at Austin, 2018

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This report assesses the historic, current and future conditions two Spanish Colonial irrigation systems in San Antonio, Texas known as the San Juan and Espada acequias, respectively. The two acequias are the only functional remnants of what was once a city-wide system which supported thousands of early San Antonians. Today, the two acequias are managed separately, each in a way that reflects their complicated history and institutional structure.

This report relates in detail those histories and parses out the complex institutional structures in the context of the rapid urban growth of San Antonio and wider challenges such as climate change and groundwater depletion. It demonstrates that the acequias democratic, *derecho*-based water and land allocation structure is a valuable institutional model for resilient resource management regimes, however their continued existence will require significant adaptation to contemporary legal, political and ecological realities.

With this in mind, this report seeks to identify theoretical frameworks with which the acequias could be restored and adapted for these contemporary realities as urban agriculture system while maintaining aspects of their traditional water and land allocation structures. It identifies the acequias as social-ecological systems (SES) that could be incorporated into a broader ecosystem services valuation of the San Antonio River watershed. It argues that the National Park Service (NPS), a major stakeholder in the acequias, should adapt its definition of Cultural Landscapes to better support working lands within their purview. Finally, it identifies the development status of the 1,750 acres of land (broken down by parcels) potentially irrigatable by the acequias and quantifies the potential yield of those parcels as supporting 38,356 people's recommended vegetable consumption per year.

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Chapter One: Introduction

As the City of San Antonio surges into another phase of tremendous growth, the natural resources and land which has made the San Antonio River basin an appealing place to settle for thousands of years are under more development pressure than ever. In the San Antonio River basin between 1997 and 2012, historic cropland was reduced by 86,955 acres, while population rose by 380,000 people and land value rose by 217% (Texas A&M 2018). While the city has managed to maintain water demand through conservation measures, outside stressors such as climate change and regional growth are impacting the city's water supply. This stress on water supplies and rural land conversion is emblematic of the unsustainable growth patterns that we see throughout the state of Texas and most areas of the United States.

These facts come at a time that there is a growing consensus that locally grown food - either in the suburban or peri-urban contexts - is crucial to the resilience of cities as we move further in to the era of climate change (Doherty 2015). Locally grown food can provide superior nutrition to industrial farms at affordable prices by increasing the availability of fresh produce to underserved communities. The farms can reduce the carbon footprint of food by selling to local markets and thus reducing transportation costs. Small, local farmers are more likely to use traditional and organic practices, reducing pollution from fertilizers and farm waste. These traditional and organic practices can protect agrobiodiversity through the use of heirloom crops that can adapt to changing climatic conditions (Jackson 2007). If enough farms are preserved, they can create a greenbelt around the city that promotes denser growth while protecting wildlife habitat. Finally, locally grown food can culturally reconnect urbanites to the rural land on which they depend upon, bridging the human / nature nexus (Vickery 2014) These benefits are all major steps towards urban resiliency in the face of uncertain future.

In addition to the importance of local food systems, decentralized and democratically accountable water management systems have been demonstrated to be a more environmentally just and resilient approach to water resource management than traditional centralized management or neoliberal water privatization (Gunn 2014) Simply put, decentralized systems are more responsive to the specific conditions in which they operate, such as the historic and social structures of a given community. By increasing a community's ability to participate in decisions regarding their water supply, the decisions tend to benefit the many rather than the few. As more communities have more options regarding how their water is managed while institutions create a matrix of support, the redundancy of the systems improve the overall resiliency of society to things like climate change and political instability (Barthel et al. 2015).

This report makes the broad argument that the City of San Antonio and cities like it would benefit from instituting programs that implement local food and decentralized water systems on a bioregional scale - in this case, the San Antonio River basin. As a model for how such systems could be implemented, this report examines relatively small but remarkable examples of a historic, integrated food and water systems in San Antonio that have been preserved by the resiliency of its infrastructure and tenacity of its participants. These systems are known as the San Juan and Espada Acequias, which are components of a once vast network of irrigation canals that served as the hydraulic system of the San Antonio Spanish colonial missions, and for many years, the city itself. Most of the acequias of San Antonio are lost to history or relegated to museums, but the Espada and San Juan Acequias continue to operate much as they would have in the colonial era.

This report serves to document the current operation and management of these acequias, as well as make recommendations for their protection in the uncertain future. The objective of

this paper is not merely to advocate for the protection of unique historic and cultural resources, which in its own right would be a worthy goal. This report is intended to elevate the acequias' unique collaborative governance structure, their capacity for environmental resilience, and their built-in tendency to support sustainable land-use decision making. I believe these qualities make the acequias compelling models for San Antonio and similar cities to draw upon as they make the turn toward local food systems and decentralized water management.

Historic Context

Nestled among majestic pecan trees and picnicking families in Breckenridge Park in San Antonio, Texas, flows a humble watercourse known as the Acequia Madre de Valero. For centuries the Mother Acequia served as the backbone to the hydraulic system that provided water to Spanish colonial missions in San Antonio, including the Mission de Valero, commonly known as The Alamo. While to a layperson the acequia might appear to be little more than a cleverly dug ditch, it in fact represents the cumulation of over a millennia's worth of hydrological knowledge and communal management practices.

Acequias were likely first developed by Middle Eastern farmers thousands of years ago, brought to Spain by the Moors in 711 A.D. and finally to the New World by the Spanish in the 1500's. Once in the new world, the practice was hybridized with traditional indigenous irrigation systems, and now represents a mestizo water management system that is distinctly pre-modern and pre-capitalist, yet is still practiced in North America to this day (Gunn 2016, Arellano 2014 pg. 78). The Spanish used acequia technology in what are now the states of Texas, New Mexico, Colorado, Arizona and California to irrigate the farms to support their missions, military outposts, and frontier settler communities. The majority of surviving acequias are clustered in

Hispano settlements of Southern Colorado and Northern New Mexico such as Taos and Santa Fe, however, the oldest surviving and continuously operating acequia happens to be our case study site, the Espada Acequia in San Antonio (Cox 2005).

Acequias' physical components are composed of a mother acequia that channels water away from primary sources such as rivers or snowmelt and into a system of smaller acequias which branch off to supply individual farms. Acequias channels are typically unlined (and thus semi-permeable, inadvertently creating riparian corridors - more on this below) and are controlled by a system of sluice gates that are manually operated via adjacent dirt paths. These simple yet subtly brilliant systems are entirely gravity fed and allow for sufficient irrigation even in a variety of weather. For instance, in times of drought, water is distributed on alternating days while pressure is increased by consolidating the water into a single flow. The fields themselves are arranged perpendicular to the acequias in narrow strips known as "long-lots," and are flooded by consecutively opening individual sluice gates. After the fields have been irrigated, any runoff is channeled back into the Acequia Madre, and in the case of the Southwest, the water eventually finds its way to the Rio Grande (or evaporates) (Arellano 2014, Gunn 2014).

Perhaps more important for this report is the fact that acequias refer not only to the physical irrigation infrastructure, but to the unique democratic system with which they are maintained and operated. In contemporary terms, acequias operate like a cooperative, but with characteristics that respond to the demands of an arid landscape rather than capitalism (Gunn 2014). While the specifics can vary from region to region, the main characteristics have remained central to acequia management throughout history. For instance, "the *repartimiento*, or sharing of water, is a Moorish concept that dates back over four thousand years." (Arellano 2014) In the repartimiento, the water is divided among the water-rights holders, or *Parciantes,*

depending on the size of their farm, while ensuring everybody is allocated a livable share, even in times of drought. Parciantes pay annual dues to fund major repairs of the acequia, and are then expected to do their share of maintenance, including taking part in the traditional Springtime channel cleaning known as the *limpia*. The acequias democratically designate a *Majordomo,* or ditch master, who oversees the organization of the parciantes and general upkeep of the acequia. (Arellano 2014, Gunn 2014)

Yanaguana and the San Antonio Acequias

As previously mentioned, the acequias of San Antonio were developed to provide water to the Spanish colonial missions and adjacent settlements which were built along the San Antonio River in the early 1700's. The Acequia Madre de Valero was the first to be built, while the subsequent acequias were built as the settlements expanded. The acequias drew almost directly from the "Blue Hole," the colloquial name for the headwater spring that feeds the San Antonio River.

Figures 1: Map of the various acequias in Central San Antonio. (Image public domain)

As with the Spanish colonial missions of Meso and South America, the North American missions served double duty as bastions of Catholicism tasked with the indoctrination indigenous populations, as well as military outposts used to lay claim to the far flung Spanish imperial territories. In the case of Mission San Antonio de Valero, the advancing French frontier from the East led to the establishment of mission to head off any future conflict over the control of the Rio Grande region. The indigenous population of the region were the Payaya people, a small tribe belonging to the Coahuiltecans, the main indigenous group that populated South Texas and Northern Mexico at the time. (South Texas Plains 2006, De Zavala 1917)

Long before the Spanish first explored the area in late 1600's, the Payaya had establishing a village at the San Pedro Springs, which they called Yanaguana, or "living waters." Indeed, Yanaguana was a virtual oasis at the northern edge of the South Texas plains, where abundant springs once spouted continuously from the base of the Balcones Escarpment. Due to high levels of extraction these springs now only run during times of heavy rain, but as recently as 1850's they were still a sight to behold. The landscape architect Frederick Law Olmstead visited San Antonio in 1856, where he recorded his observations about the Blue Hole:

> The San Antonio Spring may be classed as of the first water among the gems of the natural world. The whole river gushes up in one sparkling burst from the earth… The effect is overpowering. It is beyond your possible conceptions of a spring. You cannot believe your eyes, and almost shrink from sudden metamorphosis by invaded nymphdom. (Olmstead 1856).

At the time of Olmstead's visit, San Antonio was still reeling from the Texas Revolution, which had laid siege to the city only twenty years prior. In his account, he describes the consequences of the war on the acequia system, which had supported a large population of Mexican farmers before the war.

> The system of aqueducts [acequias]… extended for many miles around San Antonio… [The Mexican population] lived by agriculture, returning at evening to a crowded home in the city… A large part of them are abandoned, but in the immediate neighborhood of the city they are still in use, so that every garden – patch may be flowed at will. (Olmstead 1856).

Thus the acequias descended into disrepair for nearly 150 years, as their flows were usurped by municipal water infrastructure, their canals paved were over by urbanization, and the baseflow of the San Antonio River suffered from groundwater depletion. Only fragments of the system remain undisturbed, including our case studies: the Espada and San Juan Acequias. These acequias have been integrated into the fabric of the San Antonio Missions Historic Park, and through a concerted effort between a complex assemblage of partners, they are being preserved and, in some cases, restored to a semblance of their original capacity. Chapter four of this report offers a detailed summary of the process by which these acequias were built, original used, preserved and eventually restored. This history is crucial to understanding the unique structure of contemporary management regimen (Rivera 2003).

Acequias of New Mexico and Colorado and the Legal Challenges of the Commons

Despite their shared Spanish Colonial origins, the recent history of the acequias of Texas is quite distinct from the recent history of the acequias of New Mexico and Colorado. While the acequias of the Colorado and New Mexico are not the focus of this report, it is important to understand their history and status in comparison to the acequias of San Antonio as their irrigator communities are far more active and their condition well documented in the literature.

In the case of San Antonio, the Texas Revolution and land use changes related to urbanization were the main factors in the demise of the acequia system. However, in other North American Spanish territories, these systems did not face the same challenges, and thus there are approximately 900 working acequias spread across southern Colorado and Northern New Mexico, an area roughly encompassing the Rio Grande Bioregion (Rivera 1998). Here, the

acequias face a different set of challenges that are legal in nature and compounded by increasing water scarcity due to climate change and over allocation (Gunn 2014).

In the Rio Grande Bioregion, land was settled primarily through land grants provided by the Spanish, and later Mexican governments. As the settler population of the region grew, over appropriation of land and water was avoided by expanding settlements further into the northern reaches of the Rio Grande watershed and adjacent arid land. Thus, economic and environmental sustainability was built into the settlement patterns, while land under petition for settlement would be inspected by the Alcalde Mayor, a local official, to avoid conflict with the native Puebloan Indians and other settlers (Rivera 1998).

Most of these historic land grants remain unincorporated even today, meaning the acequias are the only sub-county political subdivision for much the region and are used by locals as means to identify one's place of origin. The acequias cultural and political geography was affirmed by New Mexico state legislature in 1965 when they were officially declared a political subdivision of the state and granted financial powers to borrow money and accept grants from the government. Additionally, the Federal Government recognized the acequias in 1986 as public entities that are empowered to sponsor water - related projects (Rivera 1998).

In legal terms, acequias operate as a commons, which "is a middle ground between public property with government management or enforcement, and private property with its clearly defined individual or corporate rights. In chapter two, will review the literature regarding the governance of the commons in the context of the San Antonio acequias, but for now it is sufficient to understand that "people who hold a resource in common (common pool resource) can decide how to use it, limit its use, and manage its limited use (Gunn 2016)." Although rare

today, commons are a well-established concept throughout history for the management of land and resources.

In the case of the acequias of Colorado and New Mexico, the water rights still reflect allocation via the system established by Mexican water law, where the rights are "tied to the landscape and to the community economy it has created, rightfully belonging to the community that built the irrigation structures that first made the water available" (Pena and Hicks 2003). This historic system is in conflict with the contemporary doctrine of water right allocation in the American west, known as the doctrine of prior appropriation. Prior appropriation states that the first user to take the water for "beneficial use" is allocated senior water rights, and these rights are *not* tied to the landscape or obligated to take into account community structures. Thus, "Because the law no longer insists on sharing in times of scarcity, nor offers formal encouragement to acequia institutions, commitment to the older norms must of necessity be voluntary and based on mutual persuasion by those within the acequia communities" (Pena and Hicks 2003). While acequia parciantes frequently own senior water rights, they are constantly under pressure to split these rights from their land and sell them at lucrative rates to outsiders. As water scarcity intensifies in the southwest, these water rights will only increase in value, imperiling the long-term viability of the acequia systems (Gunn 2016).

An example of an acequia that has persevered in this region despite legal and environmental challenges is the San Luis People's Ditch, an acequia in southern Colorado. This acequia represents the oldest water right in Colorado, after being built in 1852 to support farmers near the town of San Luis. This acequia, along with 72 others in the upper Rio Grande watershed, are represented by the Sangre de Cristo Acequia Association, who organize legal and educational support for the approximately 300 families who depend on the water for their

livelihood. Together with the association and academics such as Devon Pena, the San Luis parciantes are currently seeking a historic landmark designation for the People's Ditch to protect its viability for generations to come (Sangre de Cristo Acequia Association 2017).

Additionally, the ditch supports the one of two land commons still officially in use in the U.S. (the other being the Boston Commons) called La Vega. La Vega was once a large land grant stretching across Colorado and New Mexico but has dwindled over the years. The land is now 500 acres of grazing space that is democratically managed by an elected board of San Luis Vega, Inc, a non-profit formed to protect the remaining acreage. (Gunn 2016) La Vega is not only an economic and cultural asset, but an ecological one - the microbiome it supports is unmistakable from the aerial viewpoint.

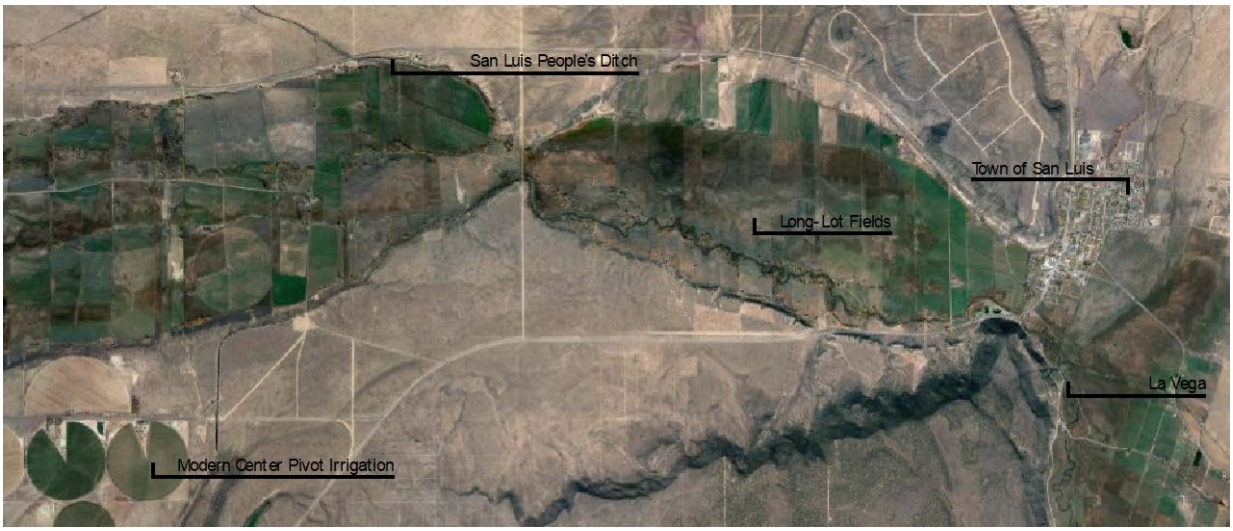

Figure 2: Aerial view of the San Luis Acequia System. (image from Google Maps 2017)

This very ecology is outlined brilliantly by Pena and Hicks in their extensive legal brief on the acequias, but in summary acequias are by nature an indispensable tool for supporting ecosystem services related to its agroecology. Acequia's ecosystem services and their contribution to land protection policies are detailed in Chapter Five; however, the following is a

short summary of serviced provided by the San Luis Acequia System.

- The unlined ditches support vibrant riparian ecosystems, which in turn provide edible and medicinal plants to the Parciantes.
- Acequias preserve, create and replenish soil, which is then complimented by the practice of rotational interplanting of crops.
- The polyculture of native and crop plantings leads to increased biodiversity that acts as a firewall against pests and disease, reducing or eliminating the need for chemical intervention.
- The anthropogenic wetlands greatly improve water quality as the runoff makes its way back to the main river, thus reducing the water treatment costs for the users and contributing water to some of the best trout fisheries in the area. (Pena and Hicks 2003)

Figure 3: La Vega in Southern Colorado. (Google Maps 2017)

As previously mentioned, the acequias of the Colorado Plateau are far more numerous and active than the San Antonio acequias. These examples serve as a control for this report as we delve into the details of the hybridized and urbanized San Antonio acequias.

Chapter Two: Literature Review

This report draws from a number of theoretical frameworks, historic resources and case studies to synthesize a long-term conservation and management proposal for the San Juan and Espada Acequias and remaining Labores, or agricultural fields. As will become clear from this review, there has been significant writing about acequias generally, the history of the San Antonio acequias specifically, and natural resources commons as an alternative to private or public control. There is a gap in literature regarding the San Antonio acequias current status and management scheme, which is unique among both National Parks and Acequias. More broadly, there is a gap in the literature critiquing how cultural landscapes are managed by the National Park Service, for which the San Antonio acequias can serve as a model.

Because of the broad set of ideas and histories addressed in this report, I will break down the literature review into distinct sections. **Section 1** will outline the literature regarding the theoretical underpinnings of this report around natural resource commons. **Section 2** will outline the literature around the valuation system of environmental services, particularly as it applies to acequias and riparian areas. The literature around environmental services is vast; however, I will outline the most important writings to the concept writ large and specific to the report. **Section 3** will shift to examining the historic context and literature regarding acequias at the global, regional, and local levels. **Section 4** will examine cultural landscapes as both a theoretical devise and a specific designation by land management organizations such as the National Park Service.

Natural Resource Commons

Broadly speaking, there has been a flurry of interest in the commons in the past 10 years, due in no small part to Elinor Ostrom's reception of the Nobel Prize in Economics for her

extensive work examining alternative resource management schemes to privatization or state control. Her seminal work, Governing the Commons - the Evolution of Institutions for Collective Action (1990) posits that the prevailing resource management regimes - either public or private management - are reductive and limited in terms of people's ability to collaborate and adapt in a variety of contexts. She writes that in fact, there are many ways in which people can act collectively to sustainably manage common - pool resources (such as a limited water supply) that avoid can avoid the pitfalls of solely public or private control. These collective actions can be administered by a variety of organizations, known as polycentrism, as posited by Vincent Ostrom who was Elinor Ostrom's husband and academic counterpart. (Ostrom 1961) Relevantly for this report, one of the case studies she cites are irrigation huertas in Valencia, Spain, which originate from the same Moorish practices that influence the acequias in the American Southwest and are thus similar in management structure. As a form of commons, huertas and acequias are a prime example of a natural resource governance system that neither completely public or privately managed. In fact, contemporary acequias, particularly the San Antonio examples, are a prime example of the concept of a polycentric management system. (Ostrom 1961)

Elinor Ostrom's work specifically critiques the widely cited essay The Tragedy of the Commons (Hardin, 1968) which claims that individual, rational self-interest will eventually deplete or contaminate shared resources without a coercive state or private property owner to prevent the overexploitation of resources. Hardin uses this theory to advocate for population control as a means to prevent environmental devastation. Since the initial publishing, the term Tragedy of the Commons has become an oft used metaphor for the reason behind mounting environmental problems such as climate change and deforestation. Coincidingly, a large amount

of literature has been written to examine and critique the theory and its impact. (Burger and Gochfeld 1998, Feeny et al. 1990) In one recent critique, titled Tragedy of the Commodity, Longo et al. argue that the "tragedy of the commons theory is simplistic and one-sided, in that it attempts to explain human social behavior, or human agency, without a thorough understanding of the historical social organization." The authors go on to posit that the unquestioning maxim of the growth imperative, or the Logic of Capital, under capitalism causes observers to incorrectly assumes that the propensity to follow pure self-interest is unavoidable human trait, rather one that is a "historically determined mode of social production." (Marx 1906) This critique further draws from Marx's original critique of capitalist production, in which he argues that the capitalist propensity to prioritize surplus value of a commodity (profit) over its absolute value alienates man from both his labor and nature.

Gunn (2016) extrapolates on the idea of acequias as commons, and as a model alternative natural resource management regime. Using Ostrom's simplified 8 Keys to a Successful Commons, (2010) he clearly identifies acequias as a commons in the Ostrom tradition. He then identifies numerous ways in which acequias can provide lessons for moving past simple economic production, but to the allowance of "reproduction of material life with independence." (Gunn 2016) Michael Cox takes the application of Ostrom's work a step further by implementing the Social-Ecological System (SES) framework to analyze the components that make up the acequia governance and natural structures. The SES framework is an attempt to standardize the research variables in regards to social-ecological systems so research may be effectively compared across disciplines. Cox finds that the Taos acequias indeed match with the SES framework's definition of a sustainable SES but that more comparative studies will be necessary for the framework to completely bear its fruit.

Ecosystem Services and Alternative Valuation Systems

An October Revolution notwithstanding, one approach to reconcile the capitalist mode of production with the absolute value of natural resources such as water or soil is known as the Ecosystem Services model. This model, first popularized by Robert Costanza in 1997, are the ecological characteristics, functions, or processes that directly or indirectly contribute to human wellbeing: that is, the benefits that people derive from functioning ecosystems. (Costanza 1997, 2017)." This model has subsequently been adopted in numerous studies of natural systems at various scales to give evidence to the absolute value of nature that is contextualized within the current economic system.

Since the Costanza et al. seminal essay introducing Ecosystem Services in 1997, at least 17,000 academic papers have included the concept in their writing, and a significant portion of the framework has been adopted by worldwide major research institutions such as Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (Costanza 2017) Ecosystem Services were further codified in the influential Millennium Ecosystem Assessment (2005), a major transnational scientific effort to take stock of the world's ecosystems as a whole at the turn of the millennium. The results of ecosystem services assessments are useful not only to quantify a specific dollar value of natural resources, but to shift the frame of mind of policymakers to putting equal emphasis on environmental and social value as they do on traditional economic value when making land-use decisions.

The ecosystem service model has been applied to acequias in New Mexico and Colorado as justification for their continued use and protection in the face of mounting pressure from both land development and fundamentalist, wilderness centric environmental groups. Hicks and Pena (2003) cite ecosystem services as a major justification for extending legal protections for

acequias in their length legal brief in the Colorado Law Review. The authors cite acequia's ability to preserve valuable agrobiodiversity in the face of generic agriculture, its propensity to protect and create open space and cultural landscapes, and its positive contribution to soil creation and water quality as important ecosystem services that would likely be lost forever if the systems abandoned. Fernald et al. (2008) provide a detailed analysis of the direct ecological benefits of acequias as riparian systems that contribute valuable habitat and biodiversity to their environment. Fleming et al. (2014) go further by developing a rating system to evaluate the riparian ecosystem services of two acequia systems in New Mexico. Raheem et al. (2015) go as far as to develop a complete framework for assessing all ecosystem services created by acequias.

Each of these assessments predominantly focuses on the natural resource ecosystem services such as water quality or riparian ecosystems but falls short of developing a valuation of the cultural ecosystem services, i.e., recreation, aesthetic and spiritual. These services are invariably the most difficult to quantify as they are the most subjective. (Costanza 2017) However in the context of the San Antonio acequias, which are heavily developed as historic and recreational resources, this service is perhaps the most important to analyze. Therefore, in chapter five, I address a possible approach to cultural services valuation through a cultural landscape lens.

Historic Context

The precolonial and Spanish colonial history of the American Southwest is a broad topic with extensive literature from both primary and secondary sources. In the three states where acequias were predominately built, there is a strong distinction between the histories of the New

Mexico and Colorado, and Texas because of differing natural environment and the distinct indigenous groups that lived in each region (Kessell 2002, De Vaca 1542, 2013).

American Southwest acequia history is thus divided into similar distinctions, with New Mexico and Colorado sharing a body of literature that is largely focused on rural Hispano land management history, while the Texas history is centered around the San Antonio Missions and later, the City of San Antonio itself. Rivera (1998) writes an authoritative history of New Mexican and Coloradan acequias, complete with lengthy transcriptions of primary historic records such as the journals of Mayordomos. Arellano (2014) gives a more contemplative history in Enduring Acequias that spans acequias roots in the middle east to today. Following this history, he gives a poetic personal account of the daily life of those living with acequias. Peña (1998) is the editor of a collection of essays that describe conceptual histories of the New Mexico and Colorado acequias in the context of Chicano environmentalism, Hispano land ethics and ecological politics.

The history of the San Antonio acequias have been well documented as heritage, archeological, and recreational sites but there is little to no literature regarding the current and future management of the still functional acequias, and indeed the theoretical implications of that management. Fisher (1996) authors the most comprehensive history of the preservation of San Antonio, including the missions and their acequias. Waynne Cox (2005) goes into the detail regarding how the acequias in San Antonio went from the dominant public water supply to nearly forgotten remnant ditches with a few historically preserved sections. Porter (2009) gives an excellent, overview of water law and development history surrounding the acequias, but only details the time up until the early 20th century, when most of the acequias were decommissioned. The epilogue does give a brief account of 20th century water law and development; however, it is

limited in its detail. Almaráz (1989) details the system and history of land tenure at the San Antonio missions; however, the documentation ends well before the modern era. Perhaps most usefully, Rivera (2003) chronicles the legal struggle between the San Antonio River Water Authority and San Juan Acequia water rights holders that has played a major factor in how the acequia is today owned and managed.

Torres (1997) provides some of the very limited primary source material from a modern context in Voices from the San Antonio Missions, which contains oral histories of people who have lived near the acequias for generations. There is an archival copy of the Espada Ditch Company minute book from 1894-1970 that has details regarding the management of the private ditch company until the point in which small irrigator farms because less profitable due to modern agriculture.

For more recent history, one must turn to the local paper of record - The San Antonio Express News - to glean the current context in which the acequias and the surrounding area are found. Greenberg (2006) outlines the process by which former mayor Ed Garza initiated the "City South" economic development plan that led to the establish important economic nodes such as a Toyota vehicle manufacturing plant and the Texas A&M University at San Antonio campus in the in 2003 and 2009, respectively. Lucio (2013) and Davila (2016) chronical how Terramark, a Houston based development firm, tried and failed to develop an 1,850 acre master-planned community adjacent to the Espada Mission, including on farm land irrigatable by the Espada Acequia. Zoning data from the City of San Antonio confirms that a development friendly non - annexation agreement remains in place where the proposed development was to be built, leaving the land vulnerable to future development.

Cultural Landscapes and Collaborative Management

The San Antonio River watershed is an excellent example of a Cultural Landscape, which is defined by UNESCO as a landscape that is "illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment". (UNESCO 2018) The concept of cultural landscapes is attributed to geographer Carl Sauer who studied human impacts on landscapes, especially in the modern era. (Sauer 2009) UNESCO has since used this definition to designate dozens of World Heritage Sites that do not fit typical definitions of historic sites or natural areas. Most notably, most UNESCO Cultural Landscapes are still occupied by their historic users, while U.S. National Park Cultural Landscapes tend to be managed historic sites without current occupants (NPS 2018).

This distinction is what makes the San Antonio Missions National Historic Park unique among NPS cultural landscapes, as the park not only has residents living within and directly adjacent to the park, but the park's historic infrastructure and agriculture is still being used in its traditional way. In the NPS system, the only other place where agriculture is being conducted within the park by a 3rd party is at the Cuyahoga Valley National Park, where 11 historic farmsteads are being restored by a non-profit and managed by individual lease holders (NPS 2018).

Despite this unique distinction, the San Antonio Missions National Historic Park does not have significant literature describing the conditions of the cultural landscape or its management. The NPS produced at least cultural landscape reports for sites within the Missions Historic Park; however, they are both limited to essentially inventories of historic sites and resources (NPS 1997, 2002).

Because of this gap in the literature, it was important to reference cultural landscapes from other countries, as well as the UNESCO World Heritage Site Application for the San Antonio Missions Historic Park. In 2014, the Missions Historic Park successfully applied to be designated a World Heritage Site through UNESCO. The application loosely refers to the park as a cultural landscape but does not official designate the acequia or any other area as an UNESCO cultural landscape. This leaves an opportunity for the Missions to be officially designated as a cultural landscape in the future, which may entail more protection benefits for the acequia system itself.

The application itself provides detailed accountancy of the managing parties and some information regarding the managing practices; however, detailed management or future expansion of the acequia system are not included. Nor is there any detailed management explanation from available officially from the NPS. This gap in the literature is important to fill at a time when other attempts at collaborative management with community groups, such as in Bears Ears National Monument, are under threat from political forces which hope to dismantle public ownership of National Parks in favor of neoliberal privatization (NPS 2016).

Chapter Three: Research Questions and Methodology

The San Juan and Espada Acequias are two ideal case studies and possible models for the implementation of local food and decentralized water systems in San Antonio. The acequias boast a nearly 300-year history of continuous operation and thus provide a wealth of data and experience on which policy makers can draw. Additionally, the two acequias are currently being managed in two very different ways, despite being practically adjacent to each other. The availability of comparative case-studies in such close geographic and history proximity serve to create ideal grounds for evaluating management and restoration practices. With this in mind, this report aims to address these central research questions:

Research Questions

1. Precisely speaking, what are the contemporary management structures of the San Juan and Espada Acequias?

- What are the historic, legal, and social conditions that led to the contemporary management structure?
- In the case of the San Juan acequia in particular, how does deviance from traditional acequia management affect its capacity for resiliency?

2. What mechanisms can be used to integrate the institutional wisdom of the acequias into a broader shift in land and water management in the San Antonio River basin bioregion?

- Is the ecosystem services framework an appropriate basis with which to integrate the acequia institutional wisdom, and at what scale is it most effective?
- How can the National Park Service adapt its definition of a cultural landscape to support dynamic culture systems within their purview such as the San Antonio Acequias?

3. What legal instruments can be leveraged to ensure the permanent protection of the acequia, including its land, water and traditional management practices?

- What is the outlook of the co-management scheme in terms of long-term sustainability in the context of the current erosion of federal protection of natural resources?

Methodology

1. Literature Review:

- I will review the literature regarding the management and history of Natural Resource Commons as a form of community ownership, especially as it regards to acequias.
- I will review literature regarding the valuation of ecological and cultural assets in terms of their positive contribution to their cities and the world at large.
- To examine acequias and similar cooperative resource management schemes, I will conduct a literature review on acequia history and management, specifically in the Spanish colonies in the American Southwest. I will review in detail the management schemes of acequias that are still in operation in the United States and Mexico, specifically.
- I will review literature regarding co-managing schemes between federal government and non-private land owners in the contexts of cultural landscapes.

2. Interviews with acequia managing parties

- Conduct in person and phone interviews with Acequia managing parties.

3. Geographic analysis of the total area impacted/potentially impacted by a full restoration of the San Juan and Espada Acequias.

- Determine what land is currently protected and what land could benefit from protection
- Analyze the land cover of impacted lands and compare to changes over time

- Determine how neighboring communities might be affected by acequia restoration and related environmental services.

4. Visual documentation of the acequia system and its impacts as it exists on the ground today.
    - Photograph physical components of system and related ecology.
5. Review legal mechanisms for permanent resource protection.
    - Review legal precedents and current proceedings of contested resources.

Chapter Four: Historic and Current Management of the San Antonio Acequias

Establishment and Early History

As discussed in the introduction of this report, the early establishment of the acequia system was imperative to the success of the Spanish Mission project in San Antonio. In the case of the San Juan and Espada acequias, there was no exception. Both Mission San Juan Capistrano and Mission Espada were established (after attempts to establish permanent missions failed elsewhere in Texas) at their current locations in March of 1731, and the missionaries began construction of the acequias within the first year. The acequias were painstakingly constructed with Indian laborers using metal bars and wooden shovels to dig a course through the rocky Texas soil, all while under the oversite of armed guards and missionaries. (NPS 2014, Porter 2009)

The acequias' construction would have begun with the building of a diversion dam, or *Presas,* on the San Antonio River that channels water into the acequia at a steady rate. These dams were typically made of logs and thus are all washed away today, with the exception of the Espada dam, which was made from stone and thus survives. The ditches were then dug roughly parallel to the river as they flow towards the mission's labore, but the construction was complicated by the necessity to follow natural contours in the land in order to maintain a constant slope. In this regard, the natural topography of San Antonio worked in the Spanish's favor, as it drops roughly 150 ft over the 6.5 miles between the San Antonio Spring headwaters and the southernmost point of the Espada acequia, or a gradient of .05% - an ideal grade for a slow but steady flow (Porter 2009). Each of the acequias had to maintain a perfect slope over varied terrain and in the face of obstacles such as creeks and large trees. Despite their lack of formal training and advanced surveying tools, the missionaries were able to construct perfectly

graded acequias using methods still not replicable today. With no written guide discovered that demonstrates how the missionaries knew how to construct and operate the systems, scholars surmise the techniques used from other examples of Spanish irrigation in the southwest. These systems essentially used an elaborate trial and error method to perfect the slope, using the water itself their guide. By turning the water on and watching the flow, they were able to cut precise grades while the water helped by breaking up the dry soil (Porter 2009).

Some charismatic construction details include the manner in which the acequias pass through creeks. The acequias' courses were constructed to make dramatic curves to following the grade down and over the creek - creating distinctive W shaped cuts into the landscape called "Wowees" by NPS staff. When the creek was too large to cross with a wowee, stone aqueducts would have been constructed - the only surviving example of which is the Espada Aqueduct, which has continuously transported water over Piedras Creek (Porter 2009).

Figure 4: Image of the San Juan Acequia performing a "Wowee" in order to cross a now-channelized creek at the most level gradient. (Google Maps 2018)

The Mission Espada Acequia measures 5.6 miles from the Espada dam to its outflow into the San Antonio River and is broken into two segments near the mission - the middle acequia and the outer acequia. The mission San Juan acequia is roughly 6.7 miles long, and splits into two segments - the upper and lower - to irrigate the labores. Both are mostly unlined dirt ditches around 6 feet deep, with the obvious exception of the Espada Aqueduct.

Secularization, Urbanization and Decommissioning

The water used in the San Antonio Acequias was presided over by the Spanish Law of the Indies, which differs significantly from English common law. In particular, In Spanish colonial law, the concept of *derecho vulgar*, which roughly translates to "locally determined justice" prevailed over the letter of the law, meaning litigants would argue for "su derecho" rather than saying the law was on their side. This concept, combined with the stipulation "water in the New World was for everyone's use" formed the basis for the unique acequia institutions that were specifically adapted for their local environment. (Porter 2009)

These key legal concepts would come significantly into play as the city of San Antonio grew beyond its mission roots into a secular town. The first major test of the water apportionment system was when 15 families from the Canary Islands were sent to the city by the King of Spain, causing the missionaries to complain to their viceroy, Marques de Casafuerte, that there would not be enough water to share with the newcomers. Casafuerte responded with a stern affirmation of the Spanish water law declaring that the missionaries were required cooperate with the islanders in order to divide and share the water on a rotating basis, all to be exercised within the Spanish concept of justice, or *derecho.* This ruling formed the basis for sharing water

via the acequias in San Antonio until the 20th century, and influenced many future laws and rulings on the matter. (Porter 2009)

Importantly, while water was to be shared with derecho, it was not just given to anybody who asked for it. Throughout the 18th century, water and land grants were bestowed upon settlers by the viceroy, after which settlers could take part in the shared system of water. The Canary Islander families used this to their advantage by laying claim to land granted to them by the viceroy that had already been under cultivation by earlier settlers and soldiers of the missions. Additionally, this grant system became the precursor many controversial elements of Texas water law today, including the preference given to senior water rights and the ability for those rights to be bought and sold. Finally, these water grants only allowed for the use of the water, rather than ownership, which is still reflected in the treatment of surface water in Texas water law today. (Porter 2009)

As the acequia system grew in complexity and maturity, additional mechanisms were instituted to distribute and govern the land and water. Mayordormos were introduced in the mid-18th century manage the construction, maintenance and allocation of water of the acequias. Settlers created a market for their *dulas,* or irrigation time allotments, in order to trade surplus water rights. When new land was to be granted, it was done so through a lottery between the grantees to determine which land went to which grantee. This lottery system was used to distribute the labores of the missions when they were secularized in the late 18th century between settlers and Indians living at the missions. Questionably, the mission labores ended up in the hands of mostly the settlers, perhaps because the Indians did not observe Western conceptions of private property. (Porter 2009)

The 18th century represents the peak of acequia construction and use, cumulating in a mature and competitive market for water rights between the mission, the islanders and other settlers by the late 18th century. Conflict between the different parties often arose, particularly in regard to the Missions' advantage of having Indian labor. The missionaries claimed that the settlers wanted to simply exploit the Indians; however, they themselves used coercion to maintain their free labor force. This conflict eventually became moot after secularization, when the missions declined in productivity and the Indian population was greatly reduced by disease and assimilation. Thus, competition for water became less robust as the city transitioned into the 19th century and entered a period of deep decline. The Mexican Independence Revolution found its way to Texas in the 1810's, when nearby bloody conflicts devastated the town almost to the point of collapse. After the war, the new Mexican government sent far less support to the San Antonio presido, and for decades residents scraped by in the face of increasingly hostile Indian raids, cholera outbreaks (likely due to the acequias falling into disrepair) and general dire poverty.

This state of affairs cumulated in the Texas Revolution and the famous Battle of the Alamo, after which Texas gained its independence from Mexico in 1836. Between 1836 and the end of the Mexican - American war in 1848, the city's population dwindled as the predominantly Mexican population faced increased hostility by Anglo newcomers. This pattern of attrition finally ended after 1848, after Texas had become a state and the Mexican - American War ended with the US taking over vast amounts of territory in what is now the American Southwest. Following the war, San Antonio took its place as a military city and rebuilt its population with immigrants, who were segregated from the original Mexican population by the San Pedro and San Antonio Rivers.

With San Antonio firmly under Anglo control and Mexicans no longer the majority, the years following the Mexican American War represent a crucial shift from Spanish water law to Anglo water law that is reflected in today's circumstances. In the initial decades under Anglo control, the city continued its use of the acequias as the municipal water system, and even making some expansions to the system such as the Alazan Ditch on the city's west side. By this time, the traditional Spanish ditch construction techniques were forgotten, and as a result the Anglo constructed ditches failed to meet the performance standard set by the original Spanish ditches. The ditches underperformance contributed to a growing sense of dissatisfaction with the acequia system as a municipal water supply. (Cox 2005)

The most pivotal event in the transition to an Anglo controlled water supply was in 1852, when the city made a deeply questionable land and water deal with city alderman James R. Sweet. The deal sold the headwaters of the San Antonio River, the source of the entire city's water supply, into private ownership for the first time, marking the end of Spanish doctrine of maintaining a supply for the entire city. The deal was said to be necessary as the city was in financial dire straits, but the amount received by the city vastly undervalued the spring and its water rights. (Porter 2009)

This deal, and the steadily growing population of San Antonio in the mid-19th century led to the eventual demise of the acequia system as the city's water supply. Increased population meant more opportunities for the acequias to become contaminated, and despite attempts to prevent outbreaks through laws and stigmatization, mid-19th century cholera outbreaks led a growing demand for a modernized water system. In response, the subsequent owner of San Antonio River headwaters George W. Brackenridge began the private San Antonio Water Works Company that developed water infrastructure using artisan wells drilled directly into the Edwards

Aquifer. In 1899, the acequias were officially decommissioned as a municipal water system, save the few surviving acequias supplying irrigators south of the city. Thus, began the slow decline of the San Antonio River as a naturally flowing watercourse and its steady adaptation into what we now call a Novel Ecosystem. (Hobbs 2013, Porter 2009)

20th Century Legal Battles

With his drilling of artesian wells, George Brackenridge opened a Pandora's box of direct aquifer exploitation that would spread across San Antonio, until the combined depletion rate lowered the water table to the point that the original wells, and the San Antonio Headwaters, only flowed in times of high rain. This ownership and exploitation of groundwater, even when it affects surface water, has since become a controversial cornerstone of Texas water law after the 1904 Texas Supreme Court Case *W.A. East v Houston and Texas Central Railway* which established the Rule of Capture in Texas. The Rule of Capture allows landowners to exploit groundwater beneath their land even if it causes their neighbors wells, springs and creeks to go dry. This rule became especially contentious as more and more irrigators moved to groundwater as pumping technology improved throughout the 20th century.

The diminished surface water flow was of course effected by this groundwater exploitation and led to conflicts such as the 1911 case of *San Juan Ditch Company v. Cassin et al.* In the case, the San Juan Ditch Company, (which had recently been formed to represent the water rights holders along the San Juan Ditch) complained that a nearby irrigator took nearly all of the available water from the San Antonio River, leaving the San Juan Ditch with less than their right allocated them. This conflict certainly wouldn't have arisen if the San Antonio River's flow wasn't significantly dampened by upstream well operations. In any case, the courts

recognized the Spanish era water rights held by the San Juan ditch but failed to bridge the gap between Spanish water law and English Common law when surface water rights. Under Spanish water law, the right to irrigate with surface water was specifically granted by an authority, while under common law, any land owner adjacent to a body of water could reasonably use their "riparian rights" which include irrigation, without a specific use grant. (Porter 2009, Rivera 2003)

This conflict came to a head in the 1958 case *San Antonio River Authority v G. Garrett Lewis, et al.* when the San Antonio River Authority, or SARA, channelized the San Antonio River in such a way as to leave the San Juan acequia high and dry, effectively cutting off the gravity flow of water to the oldest water right in Texas, which had been exercised continuously for over 200 years. In the litigation, the irrigators argued that their Spanish granted rights to water from the river should be recognized under contemporary law, including the protection of their diversion dam, which was destroyed in the channelization process. SARA argued in turn that the rebuilding of a dam would compromise the flood protection measures of the channelization project and therefore within their police power to destroy in the interest of protecting upstream property.

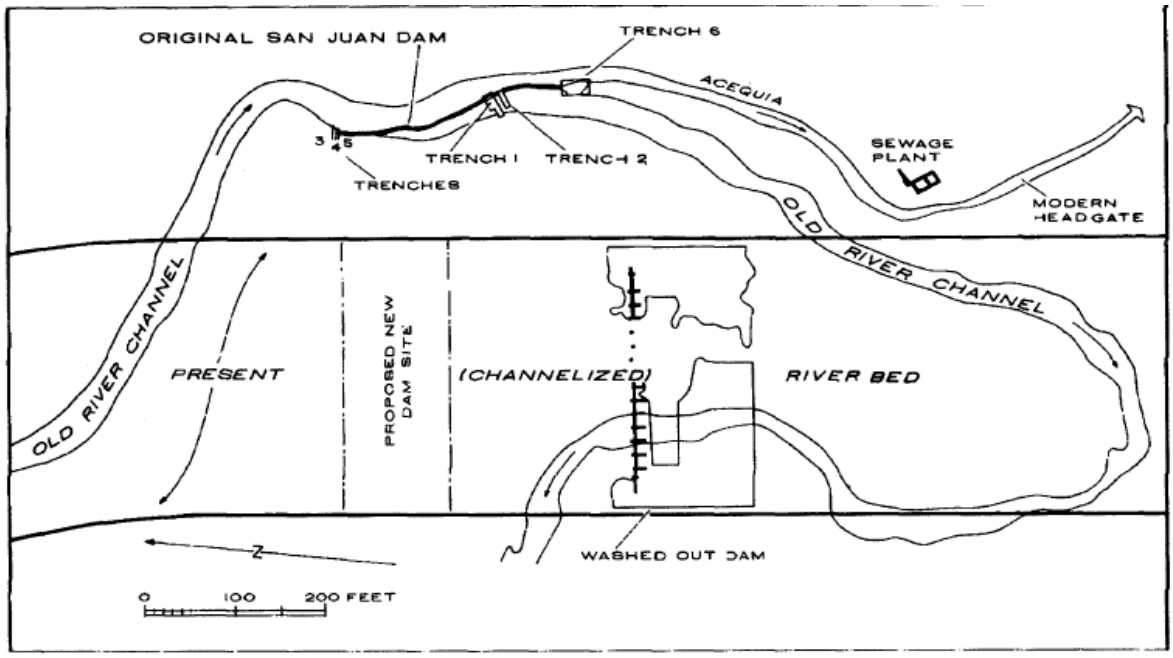

Figure 5: Map demonstrating how the channelization of the SA River cut off the original San Juan Dam. Center for Archaeological Research, University of Texas at San Antonio. (1989)

After years of litigation and two trips to the Texas Supreme Court, the irrigators won their case in November of 1962 after they reversed their initial decision that was in SARA's favor. The irrigators then turned to suing SARA for takings damages, which they eventually won in a settlement for $175,000 cash, an agreement to permanently operate the San Juan dam on behalf of the irrigators, and the provision of water commiserate with their Spanish water rights (Rivera 2003).

To prevent similar costly conflicts in the future, the Texas legislature passed the Water Rights Adjudication Act of 1967 was in order to settle the claims to surface water across the state once and for all. With almost 1/6th of the land traceable to pre-independence grants, this adjudication was no small undertaking. However, by 1969 almost all claims on surface water

were settled, while groundwater claims continue to be a major source of controversy across the state (Porter 2009).

Unfortunately for the irrigators of the San Juan Acequia, their troubles did not end with the litigation. After years without reliable water and an exhausting legal battle, many of the irrigators grew old, died, or moved on to other ventures. They still faced the problem of reestablishing flow into the acequia, which included moving water uphill from the newly channelized San Antonio River, and clearing the ditch which had fallen into disrepair. Therefore, by the time work was to be done to reestablish irrigation to the San Juan labores again, few of the original landowners remained on their land and fewer were interested in irrigating, which was growing less profitable in the face of competition from industrialized agriculture. The acequia remained dry while SARA alone was left with the court-ordered duty of reestablishing a reliable flow to the acequia (Rivera 2003).

Finally, in the early 1990's, a coalition of agencies including SARA, the NPS, and Bexar County cobbled together funds to install Archimedes screws to solve the uphill water problem, while the NPS took on the responsibility of restoring the acequia itself. The NPS started to buy up the old labores as the original irrigators died or moved on after simply being unable to wait any longer for flow to be restored. Eventually, the NPS acquired and most of the land irrigatable by the lower segment of the acequia, which had been declared a flood zone, greatly diminishing its value to individual property owners. (Oliver 2018) After a decade of work and nearly half a million dollars spent on land acquisition, restoration, the coalition of agencies celebrated the restored flow to the acequia in 2001. However, it would be another decade before the acequia was fully operational once more, ushering in a new life for the acequia in the 21st century as a collaboratively managed National Park.

Figure 6: Espada Acequia flowing in San Antonio. (image from flickr user Ken Lund)

Facing Urban Growth - Recent Development in "City South"

Urban sprawl from the rapidly urbanizing population to the north, and the fracking boom to the south, has put development pressures on the area around the Espada and San Juan Acequias. For most of San Antonio's history, the area was seen simply as a rural countryside, however various initiatives from the city and real estate interests to develop the far Southside has Found some success attracting major investment in the area.

When the city transformed the nearby 1300-acre Mitchell Lake and wetlands from a wastewater treatment pond to a Wildlife Sanctuary in 1973, it also made the area much more attractive to both housing and commercial development. In 2002, Former Mayor Ed Garza introduced the South Side Balanced Growth Initiative - later known as City South - to entice

development to the area. This resulted in the establishment of a major Toyota manufacturing facility in 2003 in an isolated area west of Mitchell Lake that has since been a major node of development in the area (Greenberg 2006).

Meanwhile, state and city leaders were making moves to establish a public university in the same vicinity to address economic equity issues in the area. The Texas A&M University established a temporary presence at nearby Palo Alto College while searching for a suitable permanent location for the new university. Around 2004, Terramark, Houston based development firm, approached Texas A&M with newly revealed plans to develop an 1,850 acre master planned community occupying the area directly southwest of the Espada mission, including significant portions of the irrigatable farm land. Terramark wanted to include the new university as the centerpiece of their New Urbanist development known simply as Espada, offering 400 acres for their campus (Davila 2016, Greenberg 2006). While waiting on a decision by Texas A&M, Terramark preemptively began accruing land for Espada, mostly from the Bexar Metropolitan Water District Utility (BexarMet) which had been land banking in the area. (Hiller 2006)

After much negotiation, in 2007 Terramark was outbid by Verano Land Group, which donated 694 acres $1 million in scholarship money to convince Texas A&M to build in their own New Urbanist development, Verano at City South, just west of the proposed Espada development. Texas A&M completed their campus with Verano Land Group in 2010, however Verano Land Group has since blamed market conditions for failing to build any of their proposed 1,825-acre development, despite receiving a blessing from the city in the form of Tax Increment Financing in 2007 (Davila 2016, Greenberg 2006).

Despite losing the bid on the University, Terramark vowed to push on with their development of Espada with the land it had already accrued from BexarMet. The Espada development happened to be *just* outside S.A. city limits, but within its ETJ, leading to its request for the city to reach a non-annexation agreement with developer and the county, while giving consent to Bexar county's creation of 3 Public Improvement Districts (PIDs) for the development. Terramark was granted its favorable zoning conditions in 2008 and looked poised to begin construction. However, the ensuing Great Recession and crash of the real estate market eventually led to the foreclosure of the land planned for the Espada development, ending Terramark's ambitions in City South (Lucio 2013).

According to the Bexar County Appraisal District, the land once slated for the Espada development is now owned by the Maraxx Operating Corporation, the parent company of discount retailers Marshalls. Since Terramark pulled out, there have been no further public proposals for a similar development on the land, however the non-annexation agreements and PIDs still stand. As evidenced in Figure 9 in chapter six, this leaves these properties vulnerable to development in the future should new investment come along.

Current Status of the San Juan Acequia - Collaborative Management and Hybridization

Area	Owner	In Cooperation With	Management Structure
Mission Valero (The Alamo)	State of Texas, Texas General Land Office	The City of San Antonio	The state operates the Alamo as a museum while the city maintains district around the mission

Table 1: Management and Ownership Matrix (NPS 2014)

Mission Espada compound, Mission San Juan compound, Portions of Mission San José compound, Mission Concepción compound	Archdiocese of San Antonio, Bexar County (portion of San Jose Compound)	The National Park Service, Texas Parks and Wildlife	The National Park Service maintains and operates all elements of the mission that are not regularly used for religious purposes. The archdiocese maintains chapel and certain religious buildings.
Mission Concepción labores, Mission to River Trail, Mission Espada aqueduct, Mission San Juan labores, Mission Espada labores, Rancho de las Cabras	The National Park Service	The Espada Ditch Company, The San Antonio Food Bank, The City of San Antonio, The SA River Authority, private citizens	See Ch. 5 sections on current status of Espada and San Juan Acequias
Acequia Park, Padre Park	City of San Antonio, The San Antonio River Authority	The National Park Service	The city operates the park as recreational infrastructure, the NPS provides additional infrastructure as needed.
Espada Dam	City of San Antonio	The San Antonio River Authority, The National Park Service	City of San Antonio maintains the structure, the NPS provides interpretive services and park infrastructure, the SA River Authority provides water for flow.
Espada Acequia	Espada Ditch Company, Arthur Maspero Ditch Master, Espada *Acequia*	The National Park Service, The San Antonio Water Authority	The Espada Ditch Company overseas the allocation and distribution of water and helps with maintenance, the national park leads maintenance, the SA Water Authority provides water for flow.

Table 1 (Continued): Management and Ownership Matrix (NPS 2014)

San Juan Acequia	National Park Service, San Antonio River Authority, private citizens	Between owners	The National Park leads maintenance, the SA Water Authority provides water for flow.
General Infrastructure	City of San Antonio	Los Compadres de San Antonio Missions	City provides road and utility infrastructure. Los Compadres raise funds for specific preservation projects.
Portions of land within the National Park boundaries and along the San Antonio River	Bexar County, San Antonio River Authority, City of San Antonio	The National Park Service	Maintains the river banks in accordance to park, city, and river authority goals as recreational, historic and hydrological infrastructure.

Table 1 (Continued): Management and Ownership Matrix (NPS 2014)

In September of 2011, San Antonio politicians and acequia stakeholders gathered to raise the sluice gate near the top of the San Juan Acequia, permanently reestablishing flow to the acequia and ushering the contemporary era of the San Juan Acequia's collaborative management by the National Park and their partners. This inaugural event was the result of the previously mentioned years of preparation by the National Park Service and their stakeholders to reinstate the flow of the San Juan Acequia but was only a ceremonial beginning to the process of restoring the acequia to its original functionality. Between 2011 and 2018, the National Park Service and their partners have worked to restore irrigation to the labores currently under National Park Management. The following pages will outline the process by which these fields are being restored and turned over to community partners.

As a National Historic Park, the primary goal for the restoration of the San Juan flow was to provide irrigation to two interpretive labores which are used to grow traditional staples, as well as a small vegetable garden for school groups and volunteers to experience the irrigating and growing processes first hand. Because of its status as a primarily interpretive resource, the San Juan Acequia flows continuously so that visitors at all times of the day can always experience the system much as it would have operated in colonial times. Of course, traditionally acequias only flow when labores are actively being irrigated, but because of the seniority of the San Juan acequia's water right and relatively little use of that right, there is no necessity to shut off the flow between irrigations. (Oliver 2018)

In the time since the flow was restored to the San Juan acequia, the National Park Service has partnered with the San Antonio Food Bank (SAFB) to cultivate a further 40 acres of the labores owned by the National Park Service. However, because the fields had been fallow for 30 years, significant field preparation such as brush removal and structure demolition was necessary before the additional labores could be cultivated. Additionally, challenges arose reinstating the traditional flood irrigation techniques because of the construction of Villamain Road and a freight rail line between the Northern segment of the San Juan acequia and the southern labores. This meant that the southern segment of the San Juan acequia can only effectively flood half of the bowl shaped labores. Because of these obstructions, the Food Bank was forced to adopt a drip irrigation method that pumps water from the acequia to the high points of the labore and run through a buried hose system. The use of drip irrigation runs counter to their initial intent of observing traditional practices but will undoubtedly use less water overall and provide an opportunity to observe an acequia being used traditionally and with modern technology side by side. This additional installation process has pushed back the completion of field preparation

work by a few years, with most of the fields only now being outfitted with the new drip technology.

Despite these challenges and delays, the Food Bank is still enthusiastic about the opportunity to integrate its significant urban farming efforts with the historic and cultural fabric of the city. The food grown on the San Juan labores is to be distributed throughout the city via the Food Banks network of charities and social enterprises, such as their "Mobile Mercado" which provides affordable, fresh produce to people living in food deserts within the city. Patrick Brennan, the Food Bank's Agricultural Initiatives and Facilities Manager, described it as a unique opportunity for the Food Bank to further their mission to reconnect people to their food and the land on which its grown while integrating with the city's heritage. The Food Bank currently produces 12,000 pounds of food per acre per year on their nearby production farm, thus it is conceivable that a similar bounty could be reaped at the San Juan farms. (Brennan 2018) A complete analysis of the potential productivity of the acequia farms is found in chapter six.

This partnership itself was formed in response to the community's desire to restore the productivity of the NPS controlled labores in the face of the reality of insufficient funding to support full-time farmers employed directly by the NPS. Thus, a mutually beneficial partnership was struck between the Food Bank and the NPS which represents a rare instance of the NPS allowing outside groups to use their land for agriculture. Functionally, this unique arrangement allows the partners to follow some aspects of the traditional acequia management structure. The National Park Service buys the right to divert water from the San Antonio River from the River Authority and allocates the water's use much as a traditional ditch company might do. James Oliver, the NPS Landscape Architect, is the de-facto mayadormo, while the various partners hold meetings to work on any challenges they might face as a irrigator community. (Oliver 2018)

On the other hand, maintenance of the acequia varies significantly from traditional methods. With the exception of segments directly adjacent to land irrigated through the Espada Ditch Company, where the Espada Mayordormo leads the maintenance, the San Juan and Espada acequias are mostly maintained by NPS staff and a rotating crew of interns, volunteers, or partners from other organizations. First of all, because the San Antonio River is flood controlled and therefore sees relatively little flood surges, the acequias are never subjected to regular floods as the once were. On the one hand, this is obviously beneficial for property protection, but on the other, the floods no longer periodically sweep the acequias of debris, meaning this labor intensive maintenance must be done manually. To perform this maintenance, the NPS previously kept a dedicated acequia maintenance crew, which would work systematically from end to end of the acequias performing preventative maintenance and repair work. According to David Vekasy, the NPS facility management chief for the missions, this worked quite well, and each successive pass became more about preventative maintenance rather than repair. Unfortunately, in recent years funding has eroded to the point that the crew has dwindled to one employee, who performs repairs on an adhoc basis with a volunteer crew. When funding or volunteers are unavailable, the employee does what he can to maintain the acequias by clearing choke points and removing downed trees, etc. This adhoc maintenance regime is sufficient for the time being, but it is "time consuming time consuming to chase funds and to work through the contracting process each year to keep those interns on-board." (Vekasy 2018)

The only other example of a partnership between the NPS and 3rd party farmers is in the Cuyahoga Valley National Park, where 11 historic farmsteads are being restored by a non-profit and managed by individual lease holders. (NPS 2018)

In addition to the labores managed by the Food Bank and directly by the NPS, an additional 45 acres of labores are soon to come under the NPS control via a land swap deal with the San Antonio River Authority. The additional land lies directly adjacent to the currently cultivated labores to the south along the south San Juan Acequia Segment and includes a productive pecan orchard. With the successful partnership with the Food Bank under its belt, the NPS is looking to expand the partnership program with additional non-profit, commercial, or even individual operators which could restore productivity to the majority of the labores that can be irrigated by the southern segment of the San Juan Acequia. (Oliver 2018, NPS 2018)

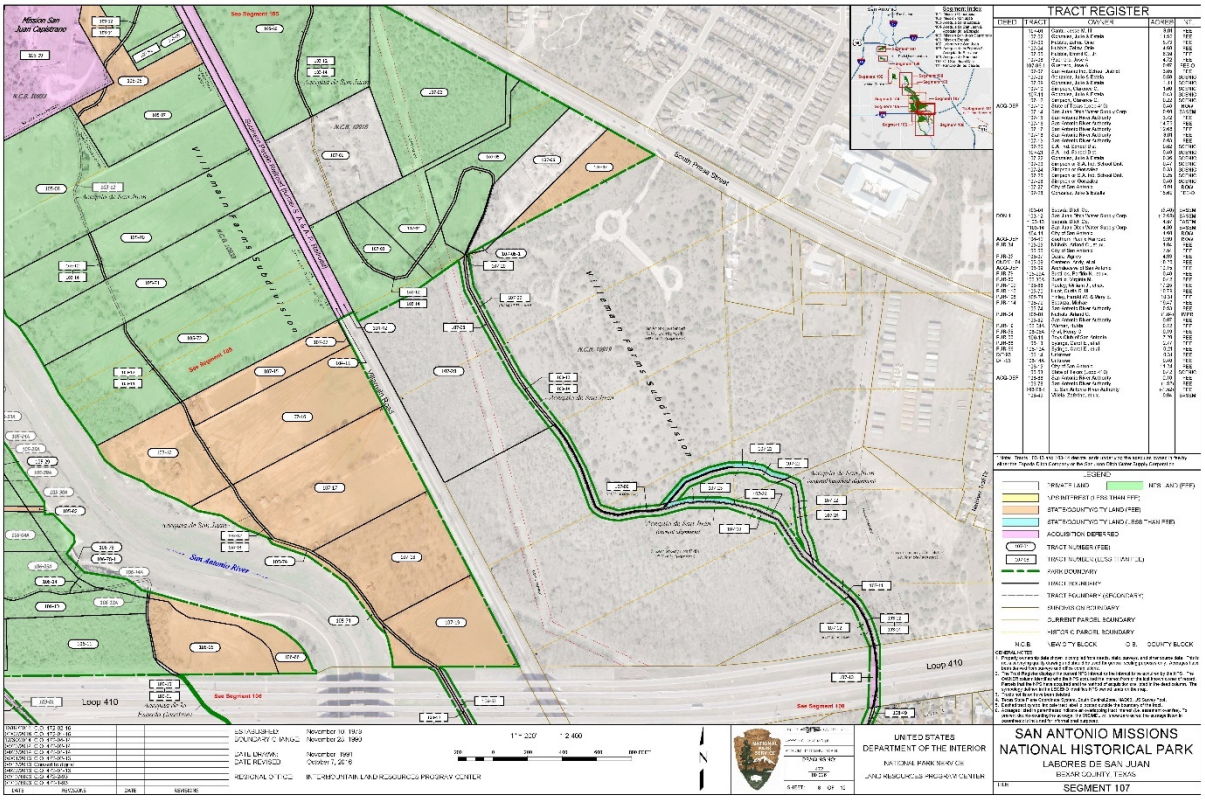

Figure 7: Map depicting current (green) and future (orange, along acequia) labores held by the NPS pending land swap with the SA River Authority. Map provided by SA Missions National Historic Park, 2018.

Finally, in the long term, the NPS hopes to restore flow to the northern segment of the San Juan Acequia, where they only currently control a portion of the irrigatable land. The majority of the land is either already developed as single-family housing, owned by the San Antonio School District as either a future school location or as a land bank, or privately owned by historic tenants. Restoring productivity on the privately-owned land would be possible and beneficial to the NPS and the acequia on the whole; however, there are additional physical challenges to restoring productivity to these labores. These challenges include once again the obstruction of Villamain road and freight rail, and a thus - far unlocated leak in ditch that prevents the flow from returning to the San Antonio River along the correct alignment. Future work may include the incorporation of Villamain as park road and augmenting it to be perforated for irrigation flow, fee-simple or other land acquisitions, and repair of the leak; however, these are all pending improved funding conditions for the park and acequia. (Oliver 2018)

Current Status of the Espada Acequia - Traditional Management and Development Protection

Today, the Espada Acequia continues to be operate much as it has for the past 265 years, however with a diminished capacity due to attrition of individual irrigators to support its operation. The Espada Ditch Company oversees the maintenance and allocation of water for individual irrigators between the Espada Aqueduct and the end of the acequia to the south. The Mayordormo, Arthur Maspero, oversees the delivery of water and some maintenance work on the ditch much as his predecessors would, however with the additional power of a backhoe and the support of the National Park Service.

While the National Park Service has some level of oversite over much of the Espada Acequia, they take a more hands-off approach to management than the San Juan Acequia, located just across the river. They work in tandem with the Mayordormo to operate and maintain the acequia and take the lead in the segments adjacent to parkland in north of 410. Additionally, they maintain a conservation easement along the length of the acequia which allows for the monitoring for any incompatible land use adjacent to the acequias which might compromise their function and value.

The Espada Labores are a jurisdictional patchwork, ranging from full ownership by the NPS to private ownership with no protection from development except within the narrow conservation easement that covers the acequia itself. The NPS owns much of the irrigatable land north of Loop 410, while the land directly south is privately held. Here, the land within the NPS Interest Area (essentially a viewshed) of Mission Espada is under a conservation easement that will prevent incompatible development of those properties in perpetuity. However, a significant amount of the land irrigatable by the in the southernmost segment of the Espada acequia are privately held, are outside of the NPS Interest Area, outside any protective zoning overlay, and in some cases, outside of the city limits. These properties have the potential to be developed in a manner that would eliminate the possibility of restoring land productivity permanently. The possible fates and protection methods of this area will be discussed in detail in Chapter six.

Chapter Five: Ecosystem Services Valuation as a Cultural Landscape Conservation Strategy: San Antonio Mission Acequia System Case Study

In the following pages I will examine the feasibility and implications of conducting an ecosystem services valuation of the San Antonio River riparian ecosystem and in particular, the agricultural component to the San Antonio Missions National Historic Park. This valuation would be transparently conducted by stakeholders as a means to expand long-term protection and resiliency of the Mission's cultural landscape by shifting the focus from the human and built capital to a more holistic focus of the natural capital of the S.A. Watershed (Costanza 2017.) (In this context, I aspirationally use the UNESCO definition of cultural landscape, see p.5 for explanation.) While this report is primarily concerned with the San Juan and Espada Acequias, I propose that the application of the ecosystem services framework would work most effectively at the watershed scale, rather than simply at the acequia scale, to express the most comprehensive view of the true value intertwined with the river and the acequias. This scale of ecosystem service evaluation also reveals the limitations of the current NPS definition of a Cultural Landscape, which could be redefined with the ecosystem services framework in mind. I conclude by arguing that by shifting to an ecosystem services valuation framework, it would be possible to shift emphasis from human and built capital investments to dynamic, life-generating natural capital investments that builds natural wealth while encompassing human, built and social capital (Costanza 2017).

The San Antonio River Authority (SARA), the City of San Antonio, and the San Antonio Water System (SAWS) have over the past 100 years created an impressive "novel ecosystem" in what was once the spring fed San Antonio River watershed (Hobbs et al, 2013). Except in times of heavy rains, the river today flows entirely thanks to recycled wastewater discharge, which is

carefully controlled by the SAWS and SARA to maintain stable water levels along the famous downtown Riverwalk and the recently completed Mission and Museum Reach trails. This novel ecosystem was built as a result of a century's worth of flood control measures and coupled with the depletion of the natural flow of the river, largely to protect and perpetuate built capital in the city. This is an important distinction from an ecosystem managed on the basis of ecosystem services, which would put emphasis on natural capital. Figure 8 below demonstrates the complex novel ecosystem that makes up the San Antonio River.

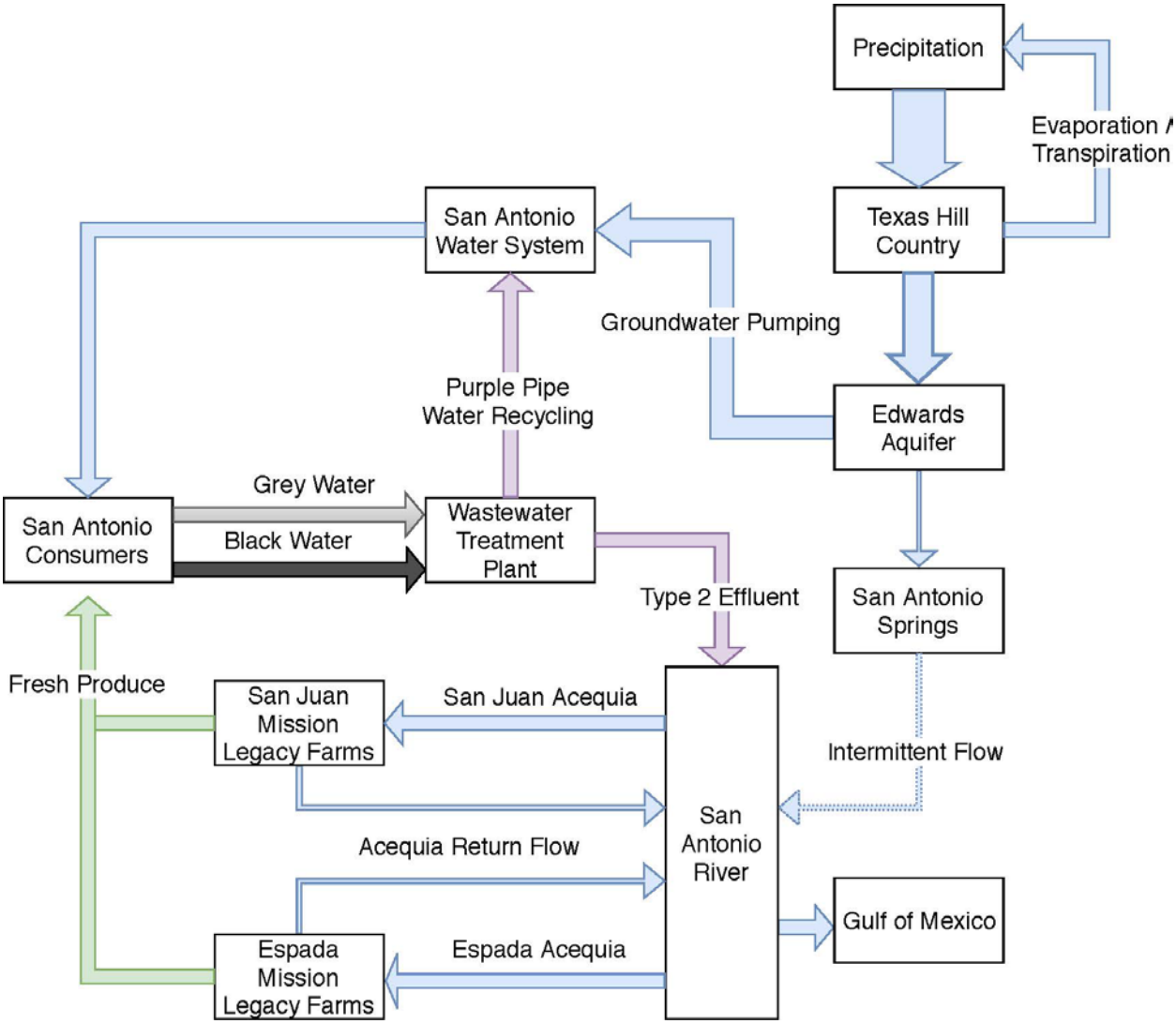

Figure 8: San Antonio River as a Novel Ecosystem

These efforts are focused on perpetuating historic and economic (tourism) value, while the riparian and agricultural ecosystems of the watershed, (which represent the only significant green space in South San Antonio,) are seemingly secondary efforts. I believe the focus on the built capital of the Missions misses an opportunity to focus efforts on regenerating the San Antonio River watershed to a productive ecological state more akin to its pre-modern condition that builds natural wealth. To achieve such goals, resource managers across the globe are increasingly turning to Ecosystem Services as their primary valuation framework (Costanza 2017).

Ecosystem services, as defined by Robert Costanza in the 1997 paper which popularized the term, "are the ecological characteristics, functions, or processes that directly or indirectly contribute to human wellbeing: that is, the benefits that people derive from functioning ecosystems." Subsequent refinement of the definition has identified four main categories of services: Provisioning (agriculture), Regulating (fresh air and water), cultural (recreational opportunities), and Supporting (soil building) (Costanza 2017). Ecosystem services valuation can help governing bodies take into account benefits to human wellbeing that are outside of simple efficient resource allocation by giving equal weight to resource sustainability and fair distribution when managing the resources which we rely upon.

In addition to the secondary consideration of ecosystem services, little public consideration is paid to the agricultural areas still being irrigated the Espada and San Juan acequias. With less public attention comes more threat of loss of resources - in this case, historically productive agricultural land being converted to suburban sprawl. Thus, it is vital to contextualize these lesser emphasized aspects of the S.A. Mission system as indications of the

ecosystem's overall function as not just an assemblage of historic sites, but as a living cultural landscape.

The missions are currently managed in the context of the National Park Service's (NPS) definition of cultural landscape is:

> historically significant places that show evidence of human interaction with the physical environment. Their authenticity is measured by historical integrity, or the presence and condition of physical characteristics that remain from the historic period (NPS 2018).

In practice, this means that opportunities to expand protections, resiliency, and ecosystem services of the Missions are limited to their current condition as a static historic landscape. However, UNESCO defines Cultural Landscapes as:

> [Landscapes that are] illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal… Protection of cultural landscapes can contribute to modern techniques of sustainable land-use and can maintain or enhance natural values in the landscape. The continued existence of traditional forms of land-use supports biological diversity in many regions of the world (UNESCO 2018).

Thus, in contrast to the static, historic NPS definition, the UNESCO definition recognizes cultural landscapes as dynamic, living landscapes. Because of this distinction, I believe a shift to Ecosystem Services valuation model would almost necessarily require a change in how the NPS service defines and manages cultural landscapes.

However, it is important to note that the most difficult components of conducting an ecosystem services valuation is often process of quantifying the value of cultural services, which are typically thought of in non-monetary terms (Costanza 2017). This presents a particular challenge for valuation of cultural landscapes that are largely thought of through a cultural lens by its stewards, the public, or both. The San Antonio River Watershed is a prime example of such a landscape, which is protected due to its significant cultural value as a rare example of Spanish colonial architecture in the United States. However, the Missions happen to occupy a

vibrant riparian ecosystem which has provide valuable ecosystem services to human inhabitants for millennias, yet today plays second fiddle to the world renown historic missions. Thus, in order to properly evaluate the ecosystem services of the San Antonio Mission and the watershed, it will be imperative to identify a mechanism for valuation of the cultural resource beyond just tourism revenues.

The acequia governance structure could offer an ideal forum for the valuation of cultural ecosystem services because of its preestablished decision-making forums and networks of stakeholders (Constanza 2017). For example, one suggestion for the valuation of cultural ecosystem services, particularly among collectives, is posited by Chan et al. (2012) who say that "[Cultural] values can often be said to be characteristic of groups, although they are generally not shared equally by all individuals. To account for these values, one should include group valuation and deliberative decision-making forums to decide on and express group values." With this in mind, it seems the democratic structure of acequia management is readymade for equitable valuation of cultural ecosystem services.

Chapter Six: Concluding Recommendations and Future Work

The San Juan and Espada acequias represent a readymade opportunity for the San Antonio Community to invest in the compounding values of urban agriculture, cultural heritage, environmental protection, recreational opportunities and community cohesion, but significant work will be needed to protect, organize and invest in the acequias as complete systems. In this final chapter I will illustrate the potential of both acequias as fully restored and operational local agricultural systems. I will then outline my recommendations for the conservation of the remaining irrigatable land that is currently outside any protection as farmland in perpetuity, followed by approaches that can be taken to promote the return to land by San Antonians through collaborative action.

The Full Grow Out

The acequias currently only support a fraction of the possible cultivation that could take place on its labores. This potential for cultivation alone represents a major opportunity to improve the ecosystem services related to the San Antonio River watershed and thus the resiliency of the city as a whole. Taking into account all of the undeveloped land that is potentially irrigatable by the San Juan and Espada acequias, including those outside of current protections or currently overgrown or fallow, roughly 1750 acres of crops could be once again cultivated along the banks of the San Antonio River. According to the San Antonio Food Bank, they cultivate roughly 12,000 pounds of produce per acre on their established production farms in on similar sites in San Antonio (Brennan 2018). Using this rate, a Full Grow Out could result in 21,000,000 pounds of vegetables per year. Using the USDA's recommendation for vegetable

consumption per young man (the highest consumption rate) these crops could supply affordable, locally grown crops to 38,356.2 people per year (USDA 2015).

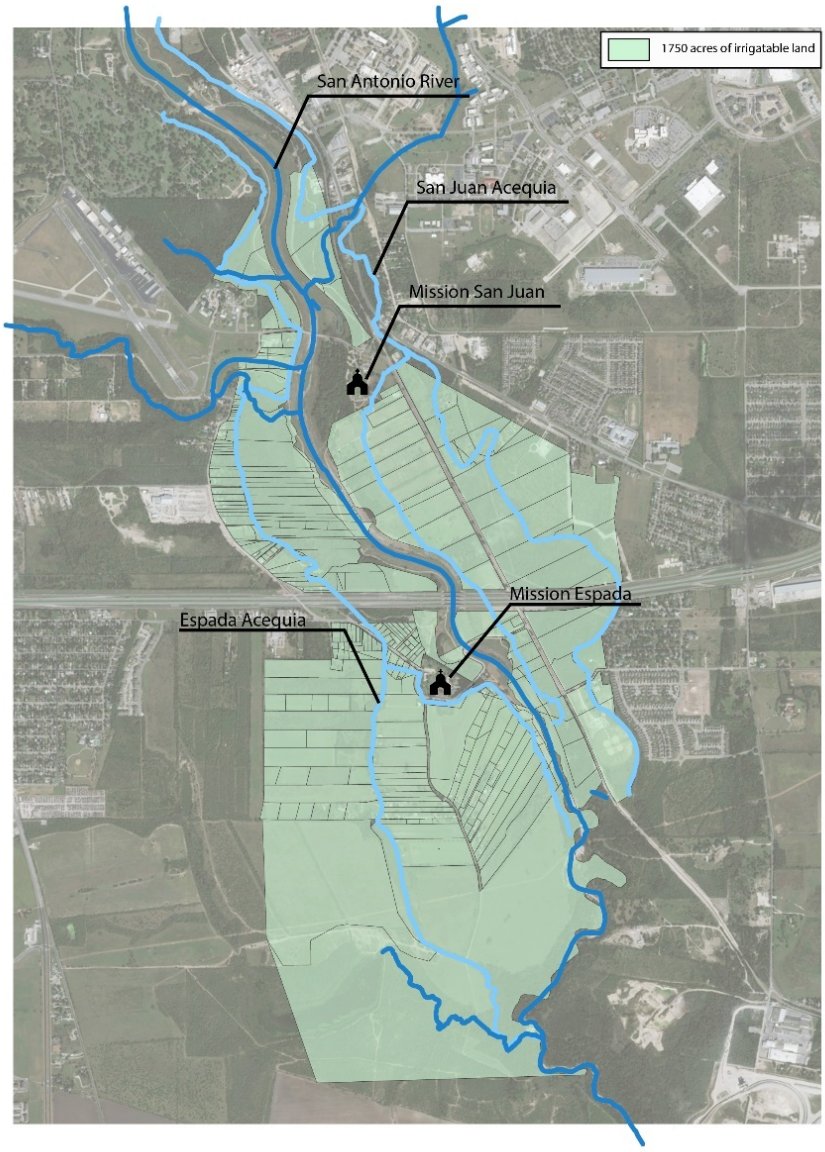

Figure 9: Map depicting the land conceivably irrigatable in a Full Grow Out Scenario. (City of San Antonio GIS Open Data, 2018)

The Full Grow Out is an ambitious goal, but one that is perfectly achievable with institutional commitment and community support. It supports the NPS' goals of creating and

preserving an authentic representation of the Missions cultural landscape, while acknowledging contemporary needs for locally grown food at a significant scale. Therefore, restoring productivity on NPS land is low-hanging fruit that can get the ball rolling and demonstrate what an agricultural landscape can support in a suburban context. Once the NPS labores are fully operational, it will hopefully be much easier to garner interest in farming within the community. Existing farmers could be bolstered by renewed community interest, improved maintenance of the acequias, and collaborative support through the acequia community institutions and supporting governmental institutions.

However, opportunities for agricultural activities shouldn't be limited to traditional subsistence style or monoculture crop regimes - after all, the acequias have already broken with tradition in plenty of other regards. One could imagine a multiplicity of agricultural activities such as permaculture, agroforestry, retreat centers, farm-to-table restaurants, subdivided community gardens, and more. For instance, the NPS is already attempting to identify and reestablish historic land races of corn used in the missions during the colonial era. These historic land races support the NPS mission as stewards of the colonial history, while their partner, the Food Bank, is more interested in productivity for their constituents (Oliver 2018, Brennan 2018). At full grow out, the acequias could support a vibrant tapestry of activities that center on the celebration of food, water and community. One precedent for such a landscape is known as a Continuous Productive Urban Landscape, or CPUL, is an urban design concept that centers on imbedding diverse types of agricultural activity directly within the urban fabric of a city (Viljoen and Howe 2005).

Exiting the Real Estate Market

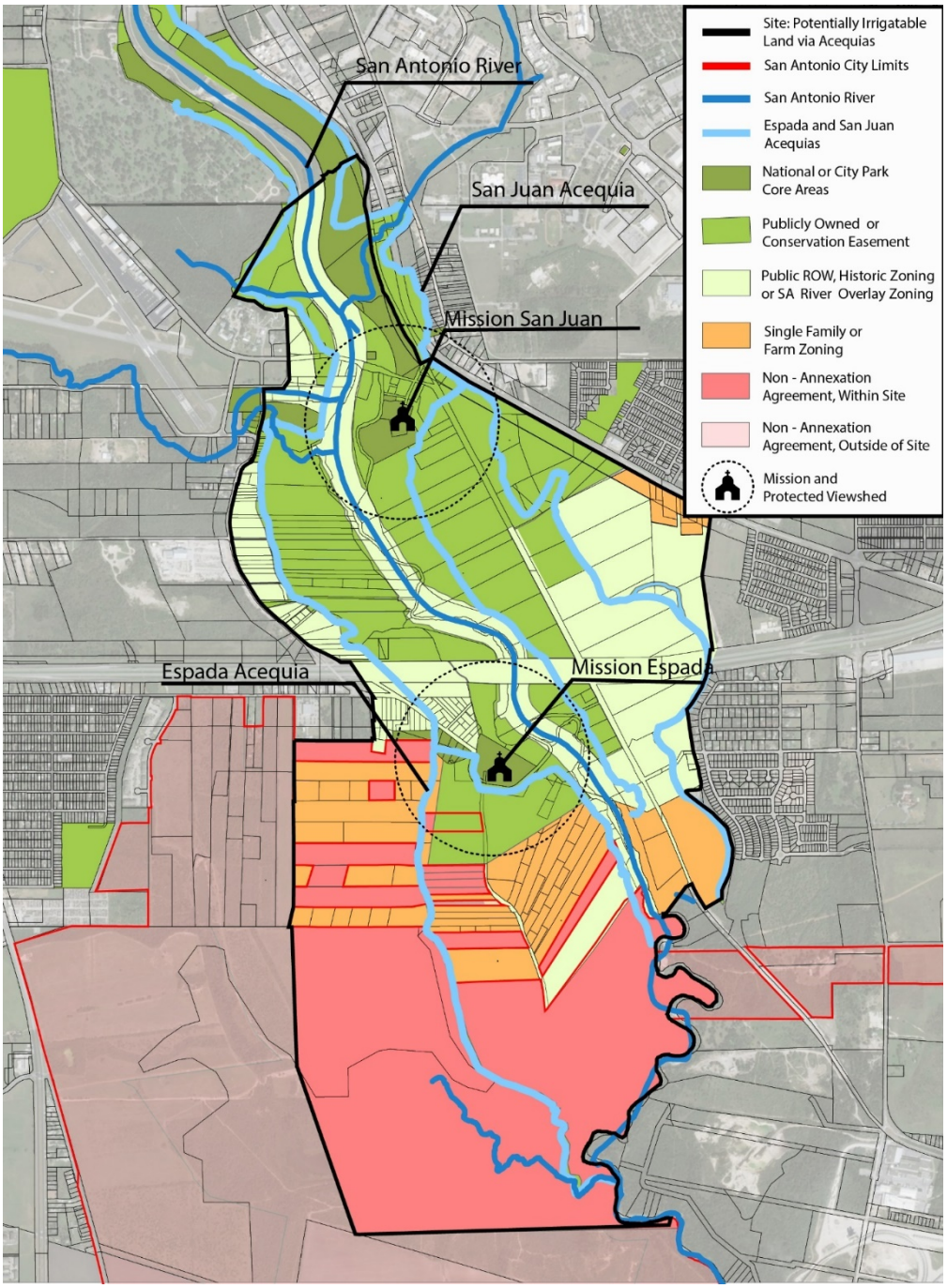

Figure 10: Zoning and protected status of the irrigatable land broken down by parcel

(City of San Antonio GIS Open Data, 2018)

While a near - full grow out could be achieved with the current protected lands, the full potential of the landscape would be vastly improved if the unprotected lands are brought into the fold. First, the upper segment of the San Juan acequia must be repaired and restored if any of those properties are going to be viable for irrigation again in the future. Second, these properties, as well as the properties at the southernmost end of the Espada acequia must be put under conservation easement, rezoned into the River overlay district or other protective zoning, or purchased fee-simple by the NPS or another interested partner. If put under conservation easement by a partner other than NPS, a land trust could be established that could one day be extended to protecting other remnant Spanish agricultural lands in the region.

These protections must be made in a way that benefits the community first, so as to not antagonize relations with the irrigator families. For instance, in exchange for putting their land under conservation easement or restrictive zoning, the NPS or city could provide in-kind support through machinery, organization capacity, landrace seed exchanges, or otherwise identified needs to ensure their success as irrigators. The land purchased by the NPS and leased to private irrigators could be offered at first to the descendants of the historic land grant holders in a type of "right to return" program. The Acequia ditch company collaborative model could be used as it is today in places like Santa Fe, where they are subdivisions of the local government and thus subject to transparency and democratic decision making.

Conclusion

Looking forward, the resiliency of agricultural systems is already under threat by climate change, soil degradation and political instability. However, the acequia system could employ stabilizing techniques such as improving agrobiodiversity, exploring more efficient ways to

irrigate in times of drought, maintaining seed reserves, and of course, improving community collaboration. Creating community is perhaps the hardest element to put into place, but also the most essential for success. The acequias themselves are already a strong model for cooperation, but it will be necessary to incorporate contemporary approaches as well. For this, one can learn from organizations such as Cooperation Jackson, which is leading the way in implementing alternative economies in the contemporary American South.

In conclusion, it is clear that the San Juan and Espada acequias not only represent a major opportunity for the restoration of a unique and thriving cultural landscape, but as a living laboratory for urban agriculture and cooperative economic systems that benefit the many rather than the few. The City of San Antonio and National Park Service should approach this restoration with the goals of environmental protection, growth management, and improving food sovereignty. Such a project would thrust these actors into to the forefront of progressive urban policy that champions people, their history, and their land.

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